

10/30/00
JC949 U.S. PTO

11-01-00

J

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BOX PATENT APPLICATIONS
Assistant Commissioner for Patents
Washington, D.C. 20231

Express Mail No. EL528823204US

JC927 U.S. PTO
09/702151
10/30/00

Sir:

Transmitted herewith for filing is the patent application of:

Inventors Larson
Attorney Docket: D-5013
Title: Wheel Mounted Power Generator and Wheel Condition Sensing Apparatus

Enclosed are: seven (7) sheets of informal drawings (Figs. 1 – 9), and
declaration and power of attorney (unsigned)

The filing fee has been calculated as shown below:

FOR	No. FILED	No. ALLOWED	No. EXTRA	RATE	FEE
BASIC APPLICATION FEE					= \$ 710.00
CLAIMS	16	20	0	x 18	= \$ 0.00
INDEPENDENT CLAIMS	3	3	0	x 80	= \$ 0.00
[] MULTIPLE DEPENDENT CLAIMS PRESENTED				x 270	= \$ 0.00
T O T A L					= \$ 710.00

[X] Please charge Deposit Account No. 14-0603 in the amount of \$710.00.
Two duplicate copies of this sheet are enclosed.

[X] The Commissioner is hereby authorized to charge payment of the following fees associated with this communication or credit any overpayment to Deposit Account No. 14-0603. A duplicate copy of this sheet is enclosed.

[X] Any additional filing fees required under 37 CFR 1.16.
[X] Any patent application processing fees under 37 CFR 1.17.

[X] The Commissioner is hereby authorized to charge payment of the following fees during the pendency of this application or credit any overpayment to Deposit Account No. 14-0603. A duplicate copy of this sheet is enclosed.

[X] Any patent application processing fees under 37 CFR 1.17.
[] The issue fee set in 37 CFR 1.18 at or before mailing of the Notice of Allowance , pursuant to 37 CFR 1.311(b).
[X] Any filing fees under 37 CFR 1.16 for presentation of extra claims.


Jeffrey P. Calfa
Registration No. 37,105

Chicago, Illinois 60611
Date: October 30, 2000
Telephone: (312) 836 3023

JC927 U.S. PRO
09/702151
10/30/00



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

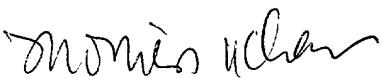
Inventors Larson
Attorney Docket: D-5013
Title: Wheel Mounted Power Generator and Wheel Condition Sensing Apparatus

CERTIFICATE OF MAILING BY "EXPRESS MAIL"

"EXPRESS MAIL" mailing label number: EL528823204US
DATE OF DEPOSIT: October 30, 2000

I hereby certify that this PATENT APPLICATION is being deposited with the United States Postal Service "EXPRESS MAIL POST OFFICE TO ADDRESSEE" service under 37 CFR 1.10 on the date indicated above and is addressed to BOX PATENT APPLICATIONS, ASSISTANT COMMISSIONER FOR PATENTS, WASHINGTON, D.C. 20231.

Monique Tk. Chan



WHEEL MOUNTED POWER GENERATOR AND WHEEL CONDITION SENSING APPARATUS

BACKGROUND OF THE INVENTION

5

Field of the Invention:

The present invention relates to vehicle and wheel assembly condition monitoring and, more particularly, to a hub mounted sensor assembly which is self energized.

10

Description of the Problem:

Economical truck operation and the reduction of vehicle maintenance costs are greatly aided by keeping the vehicle in close conformance to a manufacturer's operational specifications. Of particular concern here are those specifications relating to the operating condition of the vehicle axle and tire/wheel assembly. Maintaining proper tire pressure contributes directly to optimum fuel economy and to long tire life. Low tire pressure results in tire sidewall flex which contributes to a heat buildup in the tire. Excessively high tire temperatures promote degradation of the polymers from which tires are constructed which in turn promotes excessive wear of the tire. An axle end temperature which varies above a threshold temperature may indicate the beginning of a wheel bearing problem.

Truck operators routinely check tire pressure during stops, however, the ability to monitor all of these variables, and possibly to adjust tire pressure, while the vehicle is in motion, would be advantageous. However, accessibility to points where these variables can be measured, while the vehicle is in motion, is less than optimal. Typical active sensors, such as air pressure gauges and thermometers, work best if they can be placed in close proximity to, if not direct contact with, the object to be measured. On a vehicle, this means placing air pressure sensors onto the rotating wheel. If the condition is to be monitored from the vehicle's cab, some communication device must transfer data from the sensor to a read out device in the cab. On contemporary vehicles, in which instrumentation is highly, if not completely, electronic, this usually means providing power to an electronic sender for the wheel mounted sensor and providing a transmission channel for the data back to the cab.

Wheel mounted electronic measurement and transmission systems have been suggested which use batteries installed on the rotating wheels or in the vehicle tire to provide power to signal processing electronics and data transmission. Radio transmission can then be used to provide data transmission to the vehicle cab. Such a system obviously requires occasional checks on battery condition.

5

The prior art also provides for tire repressurization for moving vehicles. An example of such a system which can be mounted on the rotating wheel is United States Patent 5,667,606 to Renier. The Renier device uses a pendulum which hangs freely from a rotating wheel hub. The pendulum is attached to a cam on which a cam follower, attached to a piston which rotates with the hub, rides. As the cam follower rides up on the cam it displaces the piston inwardly until the end of the cam is reached, whereupon the cam follower falls off of the cam and is displaced outwardly by a compression spring in order to begin the cycle again. The piston is the active component of a pump which provides pressurized air to a reservoir which feeds tires is under inflated. The system provides no data transmission to an electronic controller or monitoring arrangement.

15

A system which can provide data to a central controller can be integrated with other vehicle control arrangements, or, at a minimum, can be used to alert the driver of a vehicle of out of specification operation. In addition, an electronic system more readily provides monitoring of diverse conditions. Providing such a system on a rotatable wheel with a minimum of additional maintenance concerns remains desirable.

20

SUMMARY OF THE INVENTION

The invention provides an electro-mechanical apparatus suitable for mounting on a vehicle wheel which provides power for sensors and telemetry from sensors on a wheel, including tire temperature and pressure. The apparatus includes a pendulum mounted to rotate freely relative to the vehicle wheel positioned from the wheel hub. When the wheel is set to rotation, the pendulum freely hangs from the wheel hub under the influence of an off center counterweight having sufficient mass to prevent rotation of the pendulum with the wheel. The pendulum is used to position one or more magnets to be used to excite field coils, which are mounted with respect to the wheel hub to rotate with the wheel. The magnets and rotating coils cooperate to energize a power utilization circuit also mounted with respect to the wheel hub to rotate therewith. The utilization circuit may include such sensors as desired, typically including a tire

pressure gauge and tire and wheel hub temperature gauges. Some embodiments include tire pressurization pumps, which may in turn take one of several forms including solenoid pumps powered indirectly from the rotating coils, or by magnetic button pumps.

5 Additional effects, features and advantages will be apparent in the written description that follows.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the invention are set forth in the appended claims.

10 The invention itself however, as well as a preferred mode of use, further objects and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

Fig. 1 is an exploded perspective view of a wheel sensor assembly in accordance with a preferred

15 embodiment of the invention.

Fig. 2 is a side view in partial cross section of the wheel sensor assembly.

Fig. 3 is an exploded view of the wheel sensor assembly.

20 Figs. 4A-B are views of a magnetic element used in the wheel sensor assembly.

Figs. 5A-B are detailed views of the magnetic element of Figs. 4A-B.

25 Fig. 6 is a block diagram of a power utilization circuit employed in the wheel sensor assembly of the present invention.

Fig. 7 is a block diagram of a power conditioning circuit utilized in the wheel sensor assembly of the present invention.

30 Figs. 8A-B are a schematic illustration of an air pump used in one embodiment of the present invention.

Fig. 9 is a schematic illustration of an air transfer circuit used to deliver pressurized air to tires mounted on a wheel.

5

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings and in particular to Fig. 1, a wheel sensor assembly 10 is illustrated. Wheel sensor assembly 10 is positioned at the end of a wheel axle 12, typically found on a medium or heavy duty truck, and may be used to provide data relating to the operating condition of the axle end and 10 for tires (not shown) mounted on wheels (not shown) depending from the axle 12. Wheel sensor assembly 10 is directed to placing low maintenance energization components, power regulating and signal gathering, conditioning and transmitting circuitry into rotation with the wheels to avoid any need for direct mechanical or electrical connections between the vehicle and the sensor components.

15 Wheel sensor assembly 10 is positioned on a backing plate 14, which in turn is mounted on axle 12. Mounting plate 14 is mounted for rotation on axle 12. Backing plate 14 is generally disk shaped and provides points of attachment for a housing 26 of the wheel sensor assembly 10. Housing 26 rotates with the adjacent wheel of the vehicle. A shaft 16 extends outwardly from backing plate 14 relative to axle 12. Shaft 16 mates with a bearing 20 which is positioned in the center of the disk shaped magnetic plate 18. 20 Magnetic plate 18 is set to rotate freely on shaft 16, but tends to keep a fixed rotational position relative to axle 12 under the influence of a relatively substantial inertial mass provided by an off center weight or pendant 22, attached to a face of the plate facing backing plate 14. A plurality of magnets 38 form the other major face of the disk shaped magnetic plate 14. Magnets 38 are flattened, pie section shaped pieces which, when fitted together form a disk facing substantially covering the outer portion of one major 25 surface of magnetic plate 18.

 Housing 26 is positioned on backing plate 14 to enclose magnetic plate 18 and a pair of field coils 24 wound on laminate substrate. Field coils 24 are mounted within housing 26 to rotate with the housing and the backing plate. Housing 26 further provides a attachment position for a printed circuit board 32, 30 and a cap or cover 34 enclosing the circuit board. An air pressure sensor 28 and air pressure inlet connection point 30 may also be positioned on the exterior shell of housing 26.

Referring now to Figs. 2-3, backing plate 14 is mounted on one side of an axle end plate 13 facing away from an end to end axle 12. Housing 26 is mounted along rim 84 in a circular recess 86 on the outward face of backing plate 14, and encloses a volume in which shaft 16, magnetic plate 18 and field coils 24 are enclosed. Wheel sensor assembly 10 is illustrated as assembled on backing plate 14. Shaft

5 16 has a threaded male end 48 which is screwed into a cooperatively threaded receiving bore 49 in back support plate 14 to position the shaft, centered in the exposed major surface and extending perpendicularly from the surface. The opposite end of shaft 16 is a reduced diameter section 47 which mates with a shaft bore 96 defined by bearing 92 (shown in Fig. 5A), which is centered in magnet mounting plate 40.

10 One or more magnets 38 may be placed on an outward face 41 of magnet mounting plate 40. A magnet 38 and field coil 24, when rotated to bring it adjacent the magnet, should be spaced by gap set to minimize flux leakage without risk of contact between the coil and the magnet. A off center counterweight or pendant 22 is attached to the face of magnet support plate oppositely faced from the face 41. Pendant 22 tends to bring magnetic plate 18 to a substantially fixed rotational position relative to axle 15 12 with the pendant below and vertically aligned by gravity with the axis of rotation of plate 18. Field coil 24 is mounted to the interior face of wall 54 which defines the shell of housing 26. Where the sensor assembly also provides tire inflation, a magnetic button pump 42 may also be mounted on the interior surface of wall 56. Magnetic button pump 42 is described in greater detail below. A pair of wires 54 is connected between field coil 24 and a printed circuit board 32 which is housed within cover 34. A breather 20 valve 52 allows air to be admitted from exterior of housing 26 via a channel through wall 56 to the interior of housing 26. Tire pressurization valves 50 are also connected by channels 51 running through the interior of housing 26 between pumps, such as pump 42 or solenoid pumps (shown below).

In the exploded view, it may be seen that axle shaft end 11 provides a foundation for mounting 25 backing plate 14. Backing plate 14 comprises two generally disk shaped elements, an larger base plate 13 adapted to provide an interface between the axle shaft end 11 and a mating disk 17 which provides attachment points for housing 26 and shaft 16. Base plate 13 attaches to axle shaft end 11 along a plurality of bolts 64 extended outwardly from the axle shaft end. Bolts 64 are inserted into holes 63 through base plate 13 and the base plate is then secured to axle shaft end 11 by the attachment of nuts 66 to bolts 30 64.

Prior to positioning base plate 13 on axle shaft end 11, a mating disk 17 is attached to the outwardly oriented face (i.e. the face oriented away from axle shaft end 11) of base plate 13 by a plurality of screws 68 inserted into base plate 13 and mating disk 17 from the inwardly oriented face of foundation disk 13 toward the outwardly oriented face. The backing plate 14 formed by the assembly of the base 5 plate 13 and the mating plate 17 then is assembled as a group onto axle shaft end 11.

Magnetic plate shaft 16 is screwed at its threaded end 48 into a cooperatively threaded hole 49 in mating disk 17. The opposite end of shaft 16 is a reduced radius end 47 onto which a magnet mounting plate 40 of magnetic plate 18 is positioned. Mounting plate 40 is retained on shaft 16 by a washer 46, 10 which is placed over end 47 and an opening through plate 40. A screw 78 is then placed through the washer and into shaft 47 to pin magnetic plate 40 on shaft 16. As described below, magnetic plate 40 incorporates a bearing allowing magnetic plate 40 to freely rotate on reduced end 47 of shaft 16.

Housing 26 encloses magnetic plate 18 and magnetic plate shaft 16 upon positioning of the circumferential rim 84 defining an edge to housing 26 into a circular channel 86 in the outer face of mating disk 17. A notch 101 is situated along the interior edge of the rim. Notch 101 provides a nesting spot for an O-ring 59 which is pressed between the faces of the notch and the interior edge of circular channel 86 to seal housing 26 against mating disk 17. Screws 68, inserted from inward face of base plate 13, through the base plate and mating disk 17 into receiving holes 82 at the bottom of the circumferential rim 84 lock 15 the housing 26 onto the backing plate 14. Counterweight 22, which is fixed to the inward face of magnet support plate 40, pulls the plate to a rotational position with the counterweight or pendant vertically below shaft 16. Backing plate 14 and shaft 16 will rotate when a wheel mounted to axle shaft end 11 rotates. 20 Under the influence, and inertia, of the mass of counterweight 22, magnetic plate 18 does not turn with the wheel, but remains substantially stationary with the counterweight below the (turning) shaft 16.

25

A printed circuit board 32 is affixed to the outward oriented shell top of housing 26. Bolts 88 are mounted through the circuit board 32 into wall 56 of housing 26 to retain the circuit board on the housing. Various circuit components 80 and electro-mechanical components, including solenoid pump 72 are mounted onto one face of circuit board 32 in a conventional manner. Solenoid pump 72 (if used) delivers 30 pressurized air to tire pressure valves 50 along air lines 73 and 75 to channels 76 and 77, respectively. Other types of pumps may be used, such as a magnetic button pump mentioned above.

Circuit board 32 is closed within a Lexan cover 34 which fits over the circuit board and mates with the outward wall section of housing 26. An O-ring 58, fitted between the cover and the housing, seals the cover against the housing 26. A plurality of screws 90 fitted through a rim to the cover 34 into housing 26 retain the cover against the housing.

5

Referring now to Figs. 4A-B and Figs. 5A-B, magnetic plate 18 is described in greater detail. Magnetic plate 18 is constructed on a magnet support plate 40, which is a flattened disk shaped member with a hole 96 centered on the axis of symmetry of the disk which passes through the disk from major surface to major surface. In a preferred embodiment, eight flattened, pie section shaped magnets 38 are disposed on one face of magnet support plate 40. Magnets 38 are arranged circumferentially around the perimeter of the major surface of the magnet support plate 40 and may be affixed thereto by gluing, or fasteners fitted through holes 94. Magnets 38 are oriented to present a pole on their exposed surfaces oriented away from the magnet support plate 40. The poles alternate in polarity, so that as they pass by a field coil 24 potentials of alternating polarity are produced on the coil.

15

Hole 96 is lined with an antifriction bearing 92 which fits around narrowed end 47 of shaft 16. Magnet support plate 40 freely rotates on bearing 92. The exterior of bearing 92 provides a support for a washer 46 used in retaining magnetic plate 18 on shaft 16. Pendant, or counterweight 22, is positioned on the opposite major surface of magnet support plate 40 as magnets 38. Counterweight 22 must be sufficiently massive to prevent magnetic coupling between one of magnets 38 and a magnet piston from a magnetic button pump resulting in the magnetic plate 18 rotating with housing 26.

Fig. 6 illustrates a power utilization circuit 100 which provides for the collection, conditioning and transmission of data from sensors. Separate pressure sensors 102, 104 are provided for each tire (not shown). A temperature sensor 106 may be placed in communication with the air within the tires to provide an indication of tire temperature. A hub temperature sensor 108, based on an air temperature sensor within housing 26 or within cover 34, may be provided. Conventional amplification and digital to analog conversion circuitry (signal conditioning circuits) 110 is provided for each signal.

The signals from each of the conditioning circuits 110 is routed through a multiplexer 112 under the control of a microcontroller 114, which can select which signal to pass to a transmitter 116 for broadcast to a remote receiver 117 located elsewhere on a vehicle. In some embodiments transmitter 116

may be replaced with a transceiver as a CAN (controller area network) remote receiver 117. In such cases remote commands such as to began inflation of a tire may be returned to microcontroller 114. Microcontroller 114 may control actuation of a switch 172 which in time controls powering a solenoid pump 72. Such signals commanding increased pressurization may come upon indication from other sources that
5 the vehicle is carrying an especially heavy load.

Fig. 7 illustrates the power supply circuitry 120 used to power the utilization circuitry 100 and the solenoid pump 72, if used. A field coil 24 is connected to a conventional rectifier 122 and filter 124 arrangement to supply voltage at a selectable level to a switching regulator 126. Since power is rectified and filtered, the utilization circuitry remains energized regardless of the direction of movement of the vehicle. Switching regulator 126 supplies power to a 5-volt regulator 128, which in turn powers the components of the utilization circuitry 100. A solenoid pump 72 receives power from capacitor 124 when
10 switch 172 closes.

Figs. 8A-B illustrate two pumps usable with the invention. Magnetic button pump 42 may be used instead of solenoid pumps, reducing power demands on the power supply circuitry 120. Magnetic button pump 42 comprises a magnetic button piston 44 retained for linear reciprocation in a cylinder 150. A diaphragm 161 seals the piston 44 against the interior wall of cylinder 150. Magnetic button piston 44 is retained within cylinder 150 by a lip positioned at one end of cylinder 150. An opening 136 allows air to
15 freely move into and out of the portion of cylinder 150 between piston 44 and the opening. Piston 44 reciprocates under the influence of magnetic poles of alternating polarity of magnets 38 passing close over opening 136. As piston 44 is drawn toward opening 136, air is pulled into cavity 151 through a one way check valve 130. As piston is pushed away from opening 136 air is forced under pressure through an outlet provided by a one way check valve 132.
20

Solenoid pump 72 is constructed similarly to button pump 42. However, instead of magnets 38 providing reciprocation of piston 44, a solenoid 155 wrapped on cylinder 150 effects movement of magnetic piston 44. Indeed, in a solenoid pump piston 44 may be unmagnetized iron. Fig. 9 illustrates a pressurization circuit usable with either type of pump. A pump 160 provides air under pressure to a
25 Schrader valve 136, to which tubing connecting the sensor assembly 10 to the tires may be provided. As illustrated a single pressure sensor 102B, positioned in the circuit between the Schrader valve and a Y-connection splitting the delivery of air to the two tires, indicates back pressure in the system when air is
30

delivered. A pressure sensor situated here displays data which in effect is an average of the pressures in the two tires. Alternatively, separate sensors may be placed in each circuit downstream from check valves 140, which prevent over pressurization of the tires.

5 The invention provides a sensor system which can be powered without use of a battery or direct external connection while mounted on a rotating wheel hub. The system returns data to a central controller and can be integrated with other vehicle control arrangements. Alternatively, a minimum system can be deployed to alert the driver of a vehicle of out of specification operation.

10 While the invention is shown in only one of its forms, it is not thus limited but is susceptible to various changes and modifications without departing from the spirit and scope of the invention.

00202454403000

What is claimed is:

1. An electromechanical apparatus, comprising:
 - (a) a vehicle wheel adapted for axial rotation;
 - (b) a pendulum mounted to rotate freely relative to the axis of rotation for the vehicle wheel;
 - (c) a magnetic element mounted with and positioned by the pendulum;
 - (d) at least a first generator coil mounted to the wheel for rotation with the vehicle wheel to pass through lines of flux associated with the magnetic elements;
 - (e) a current utilization circuit mounted on the vehicle wheel and connected to at least the first generator coil.
2. An electromechanical apparatus as claimed in Claim 1, wherein the magnetic element comprises a plurality of magnets oriented so that their magnetic poles alternate in direction with adjacent magnets.
3. An electromechanical apparatus as claimed in Claim 1, further comprising a plurality of electrical coils mounted on the vehicle wheel.
4. Our electromechanical apparatus as claimed in Claim 2, further comprising:
 - (a) an air pump.
5. An electromechanical apparatus as claimed in Claim 4, wherein the pump is a magnetic button pump.
6. An electromechanical apparatus as claimed in Claim 4, wherein the pump is a solenoid pump.
7. An apparatus for monitoring physical variables of a tire and an axle, the apparatus comprising:
 - (a) a vehicle wheel having a hub mounted for rotation on the axle, the tire being mounted thereon;
 - (b) a tire pressure gauge mounted on the vehicle wheel in communication with the tire;
 - (c) a tire temperature gauge mounted on the vehicle wheel adjacent the tire;
 - (d) an axle temperature gauge mounted on the vehicle wheel adjacent the wheel hub;
 - (e) a signal processor and transmitter mounted on the vehicle wheel and connected to the tire pressure gauge, the tire temperature gauge and the axle temperature gauge for collecting

RECORDED
SEARCHED
INDEXED
MAILED

data from the gauge and broadcasting a radio signal comprehending values representing the data; and

(f) an energization assembly including a magnetic element mounted adjacent the vehicle wheel presenting at least one magnetic pole parallel to the vehicle wheel's axis of rotation, a field coil mounted on the vehicle wheel to pass the magnetic pole periodically to induce excitation therein, and electrical filtering and supply circuitry connected to the field coil and to the signal processor and transmitter.

8. An apparatus as claimed in Claim 7, wherein the magnetic element further comprises a positioning segment depending from the wheel hub and a stabilizing element for resisting rotation of the positioning segment with the vehicle wheel.

9. An apparatus as claimed in Claim 8, wherein the positioning segment includes a mounting plate centered on the axis of rotation of the vehicle wheel; a low friction bearing centering the mounting plate on the hub;

10. An apparatus as claimed in Claim 9, wherein the stabilizing element includes an off center weight attached to the mounting plate providing inertial resistance to rotation of the mounting plate.

11. An apparatus as claimed in Claim 10, wherein the magnetic element comprises:

- (a) the mounting plate being a disk mounted to have major opposed surfaces perpendicular to the axis of rotation of the vehicle wheel; and
- (b) a plurality of magnets shaped as wedges and arranged circumferentially around the outer edge of the major surface of the disk closer to the vehicle wheel with their poles oriented to alternate with adjacent magnets.

12. Apparatus comprising:

- (a) a vehicle wheel having an axis of rotation;
- (b) a magnetic element positioned adjacent the vehicle wheel and oriented with respect to the vehicle wheel to project lines of flux;
- (c) a generator coil mounted with respect to the vehicle wheel to rotate therewith, and to intercept the line of flux;

(d) electrical utilization elements mounted with respect to the vehicle wheel to rotate therewith and connected to the generator coil to receive energization therefrom.

13. Apparatus as claimed in Claim 12, wherein the magnetic field source further comprises:

- a free wheeling plate having a major surface, rotatably mounted with respect to the vehicle wheel and positioned so that a major surface lies parallel to the vehicle wheel and perpendicular to the axis of rotation of the vehicle wheel; and
- a plurality of magnets mounted on the major surface of the plate and oriented to present poles of alternating magnetic polarity outwardly from the major surface.

14. Apparatus as claimed in Claim 13, wherein the electrical utilization elements include sensors and an air compressor.

15. Apparatus as claimed in Claim 14, further comprising an air compressor mounted to rotate with the vehicle wheel and energized by the generator coil.

16. Apparatus as claimed in Claim 15, an air compressor mounted with respect to the vehicle wheel to rotate therewith and oriented to be directed activated by the plurality of magnets.

ABSTRACT OF THE DISCLOSURE

An electromechanical apparatus suitable for mounting on a vehicle wheel power for generating telemetry relating to the wheel including tire temperature and pressure. The apparatus includes a pendulum mounted to rotate freely relative to the vehicle wheel which is positioned from the wheel hub. When the wheel is set to rotation, the pendulum freely hangs from the wheel hub under the influence of an off center counterweight having sufficient inertia to prevent rotation of the pendulum with the wheel. The pendulum is used to position one or more magnets to be used to excite field coils, which are mounted with respect to the wheel hub to rotate with the wheel. The magnets and rotating coils cooperate to energize a power utilization circuit also mounted with respect to the wheel hub to rotate therewith. The utilization circuit may include such sensors as desired, typically including though a tire pressure gauge and tire and wheel hub temperature gauges. The apparatus is readily extended to incorporate a tire pressurization pump, which may be a solenoid pump powered indirectly from the rotating coils, or by a magnetic button pump.

1/7

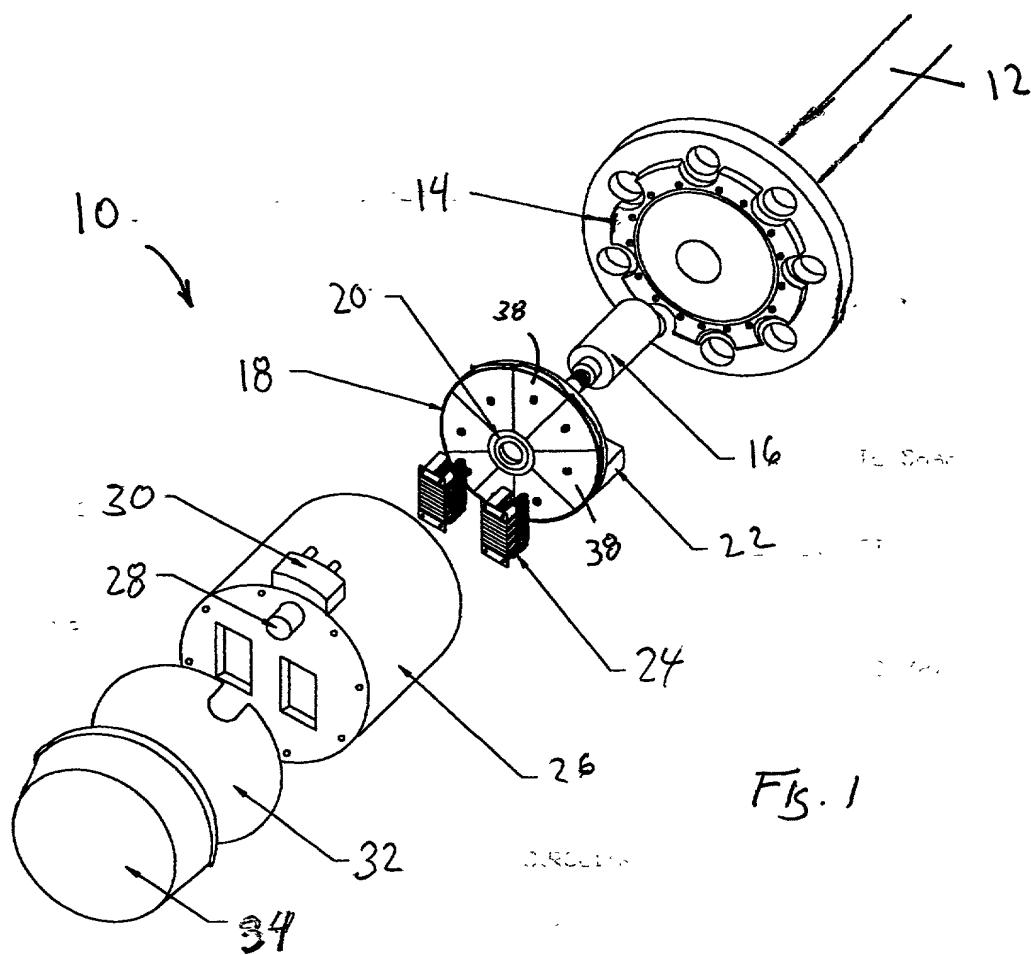


FIG. 1

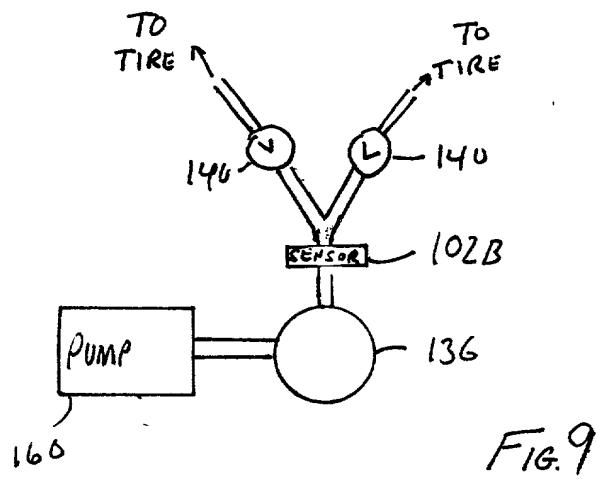
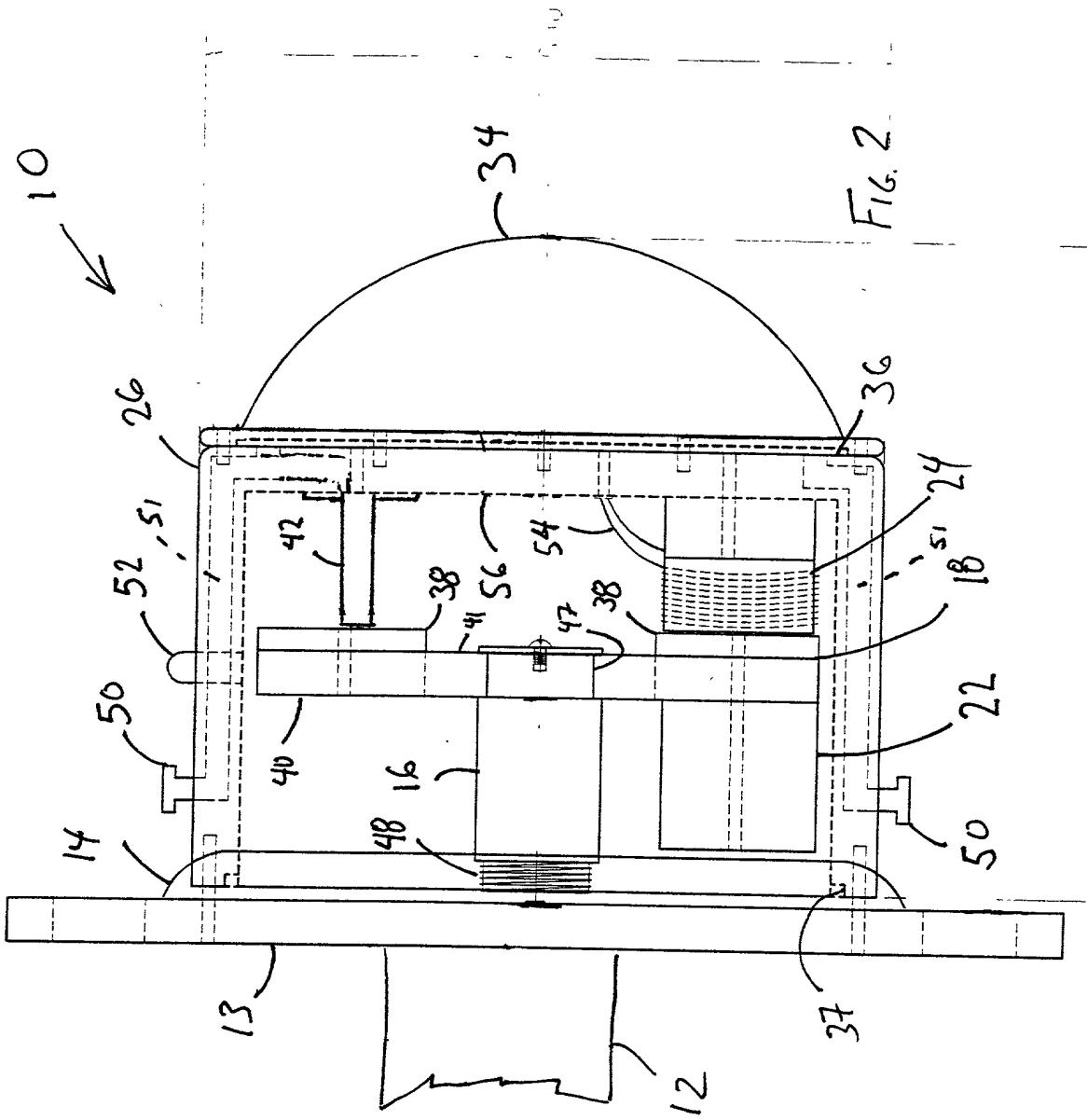


FIG. 9

D5013

SIZE

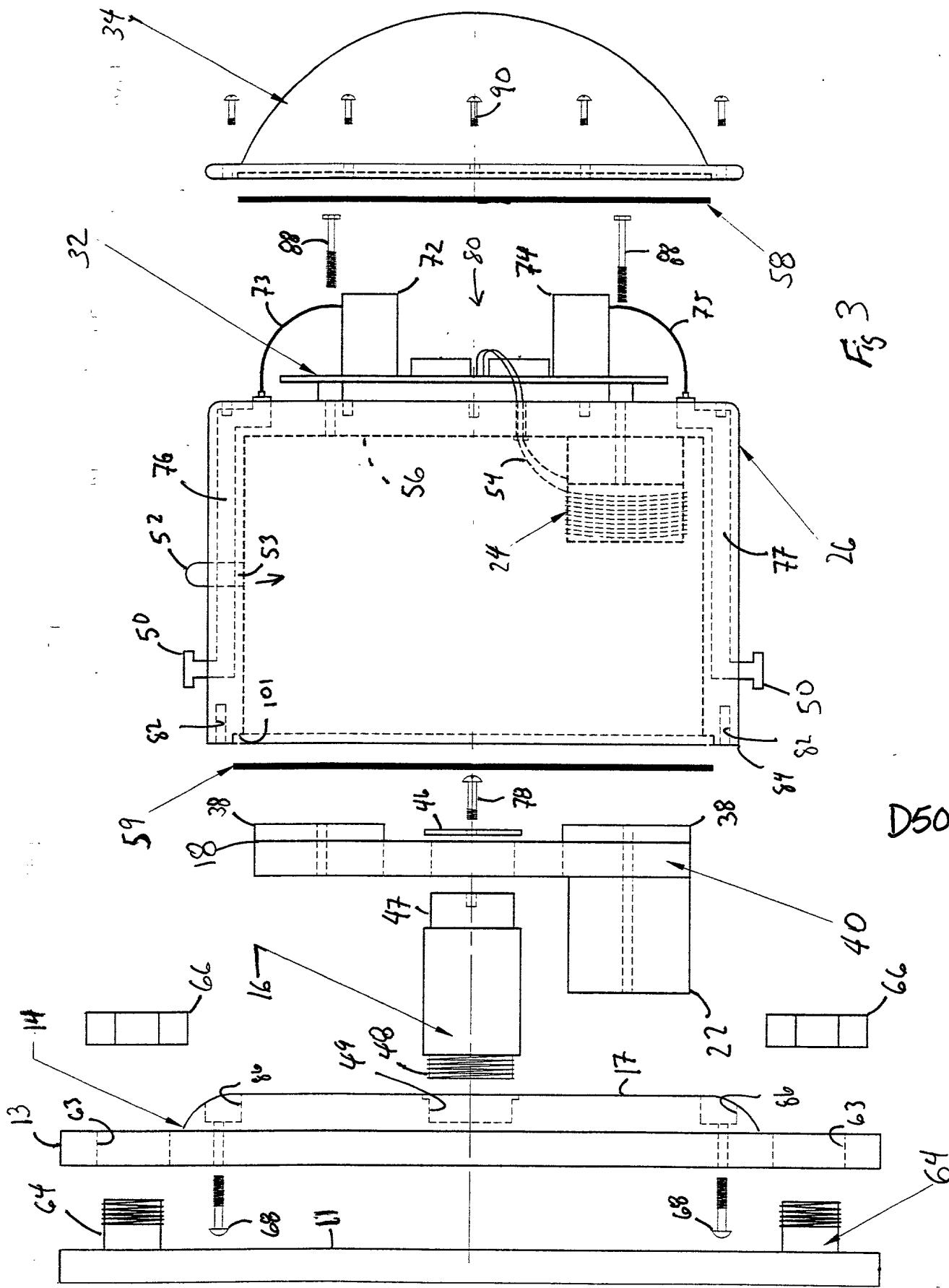


D5013

UNIT EXPLODED VIEW

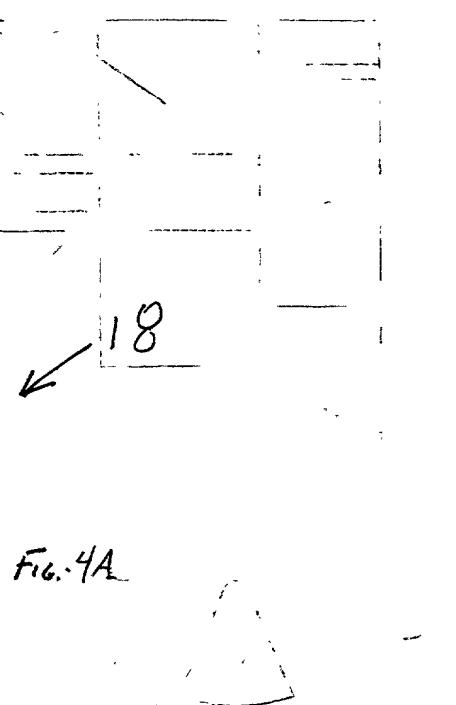
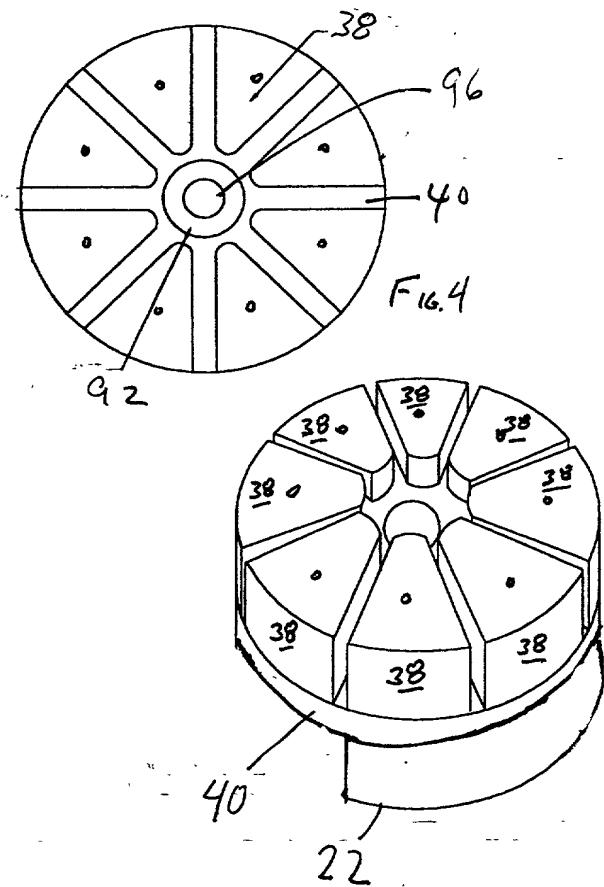
D5013

Fig 3



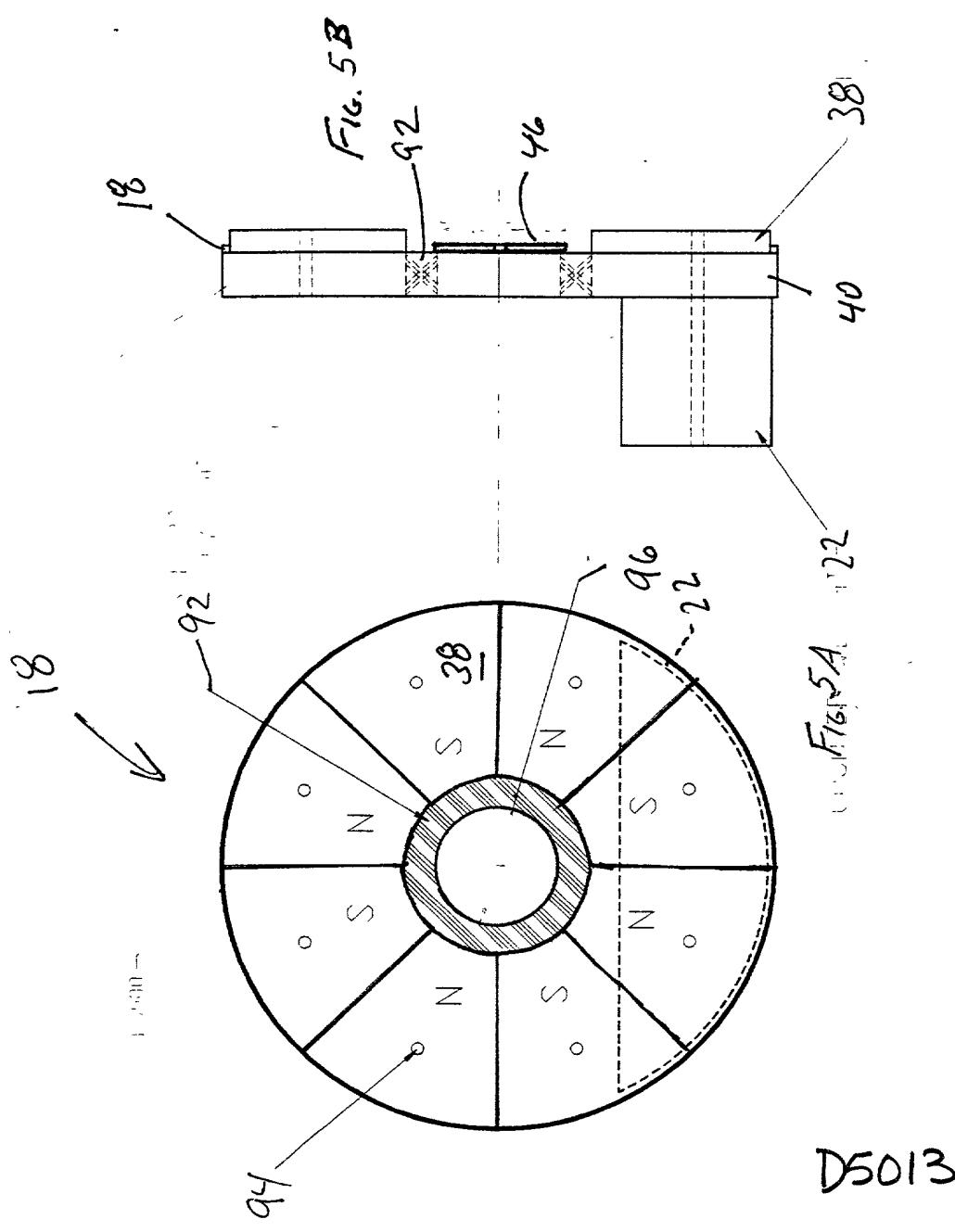
3/7

4/7



D5013

MAGNETIC CONFIGURATION W/ COUNTER BALANCE



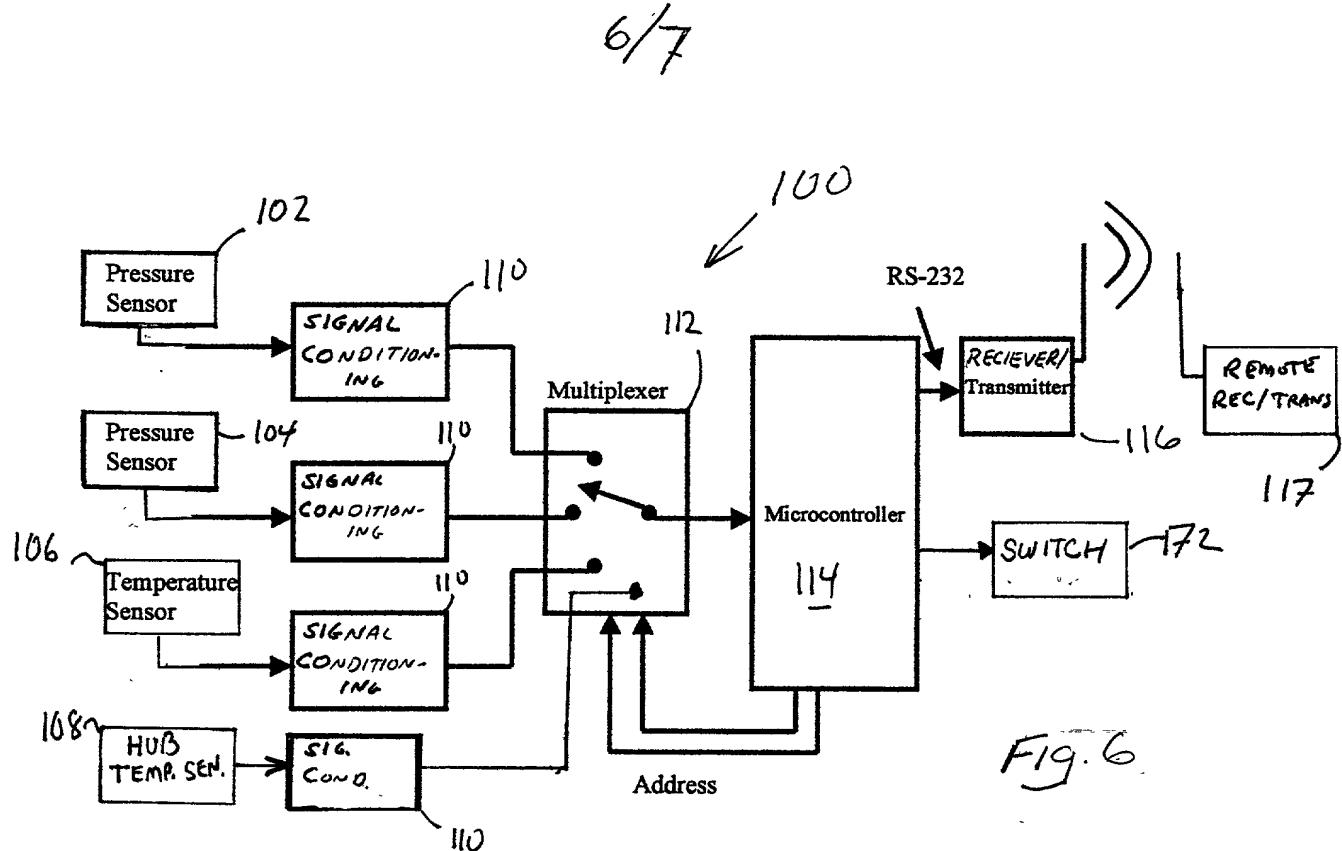
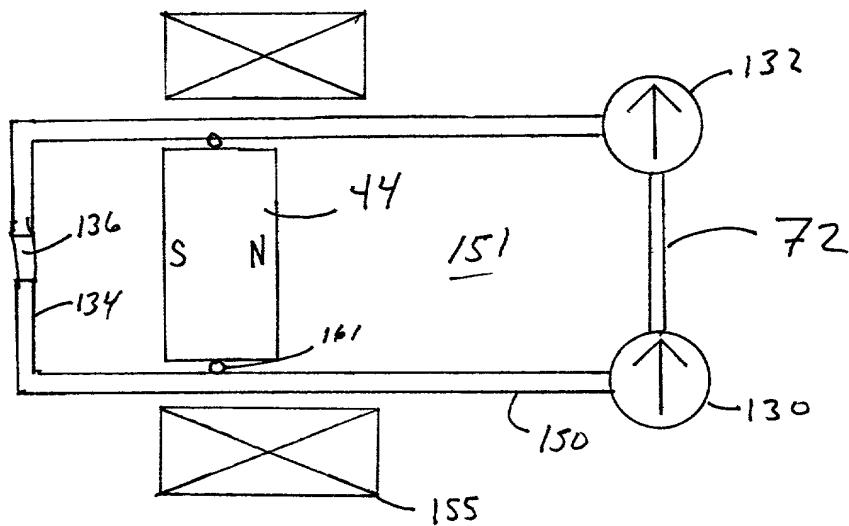


Fig. 6

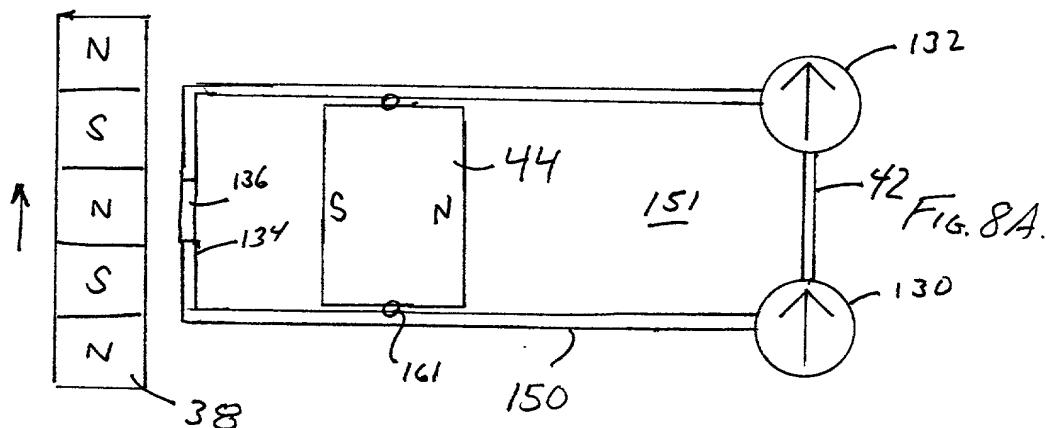
0 49 7 102 153 31 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 279 280 281 282 283 284 285 286 287 288 289 289 290 291 292 293 294 295 296 297 298 299 299 300 301 302 303 304 305 306 307 308 309 309 310 311 312 313 314 315 316 317 318 319 319 320 321 322 323 324 325 326 327 328 329 329 330 331 332 333 334 335 336 337 338 339 339 340 341 342 343 344 345 346 347 348 349 349 350 351 352 353 354 355 356 357 358 359 359 360 361 362 363 364 365 366 367 368 369 369 370 371 372 373 374 375 376 377 378 379 379 380 381 382 383 384 385 386 387 388 389 389 390 391 392 393 394 395 396 397 398 399 399 400 401 402 403 404 405 406 407 408 409 409 410 411 412 413 414 415 416 417 418 419 419 420 421 422 423 424 425 426 427 428 429 429 430 431 432 433 434 435 436 437 438 439 439 440 441 442 443 444 445 446 447 448 449 449 450 451 452 453 454 455 456 457 458 459 459 460 461 462 463 464 465 466 467 468 469 469 470 471 472 473 474 475 476 477 478 479 479 480 481 482 483 484 485 486 487 488 489 489 490 491 492 493 494 495 496 497 498 499 499 500 501 502 503 504 505 506 507 508 509 509 510 511 512 513 514 515 516 517 518 519 519 520 521 522 523 524 525 526 527 528 529 529 530 531 532 533 534 535 536 537 538 539 539 540 541 542 543 544 545 546 547 548 549 549 550 551 552 553 554 555 556 557 558 559 559 560 561 562 563 564 565 566 567 568 569 569 570 571 572 573 574 575 576 577 578 579 579 580 581 582 583 584 585 586 587 588 589 589 590 591 592 593 594 595 596 597 597 598 599 599 600 601 602 603 604 605 606 607 608 609 609 610 611 612 613 614 615 616 617 618 619 619 620 621 622 623 624 625 626 627 628 629 629 630 631 632 633 634 635 636 637 638 639 639 640 641 642 643 644 645 646 647 648 649 649 650 651 652 653 654 655 656 657 658 659 659 660 661 662 663 664 665 666 667 668 669 669 670 671 672 673 674 675 676 677 678 679 679 680 681 682 683 684 685 686 687 688 689 689 690 691 692 693 694 695 696 697 697 698 699 699 700 701 702 703 704 705 706 707 708 709 709 710 711 712 713 714 715 716 717 717 718 719 719 720 721 722 723 724 725 726 727 728 729 729 730 731 732 733 734 735 736 737 738 739 739 740 741 742 743 744 745 746 747 748 749 749 750 751 752 753 754 755 756 757 758 759 759 760 761 762 763 764 765 766 767 768 769 769 770 771 772 773 774 775 776 777 778 779 779 780 781 782 783 784 785 786 787 788 789 789 790 791 792 793 794 795 796 797 797 798 799 799 800 801 802 803 804 805 806 807 808 809 809 810 811 812 813 814 815 816 817 818 819 819 820 821 822 823 824 825 826 827 828 829 829 830 831 832 833 834 835 836 837 838 839 839 840 841 842 843 844 845 846 847 848 849 849 850 851 852 853 854 855 856 857 858 859 859 860 861 862 863 864 865 866 867 868 869 869 870 871 872 873 874 875 876 877 878 879 879 880 881 882 883 884 885 886 887 888 889 889 890 891 892 893 894 895 896 897 897 898 899 899 900 901 902 903 904 905 906 907 908 909 909 910 911 912 913 914 915 916 917 917 918 919 919 920 921 922 923 924 925 926 927 928 929 929 930 931 932 933 934 935 936 937 938 939 939 940 941 942 943 944 945 946 947 948 949 949 950 951 952 953 954 955 956 957 958 959 959 960 961 962 963 964 965 966 967 968 969 969 970 971 972 973 974 975 976 977 978 979 979 980 981 982 983 984 985 986 987 988 989 989 990 991 992 993 994 995 996 997 997 998 999 999 1000 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1009 1010 1011 1012 1013 1014 1015 1016 1017 1017 1018 1019 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 1039 1039 1040 1041 1042 1043 1044 1045 1046 1047 1048 1049 1049 1050 1051 1052 1053 1054 1055 1056 1057 1058 1059 1059 1060 1061 1062 1063 1064 1065 1066 1067 1068 1069 1069 1070 1071 1072 1073 1074 1075 1076 1077 1078 1079 1079 1080 1081 1082 1083 1084 1085 1086 1087 1088 1089 1089 1090 1091 1092 1093 1094 1095 1096 1097 1097 1098 1099 1099 1100 1101 1102 1103 1104 1105 1106 1107 1108 1109 1109 1110 1111 1112 1113 1114 1115 1116 1117 1117 1118 1119 1119 1120 1121 1122 1123 1124 1125 1126 1127 1128 1129 1129 1130 1131 1132 1133 1134 1135 1136 1137 1138 1139 1139 1140 1141 1142 1143 1144 1145 1146 1147 1148 1149 1149 1150 1151 1152 1153 1154 1155 1156 1157 1158 1159 1159 1160 1161 1162 1163 1164 1165 1166 1167 1168 1169 1169 1170 1171 1172 1173 1174 1175 1176 1177 1178 1178 1179 1180 1181 1182 1183 1184 1185 1186 1187 1188 1189 1189 1190 1191 1192 1193 1194 1195 1196 1197 1197 1198 1199 1199 1200 1201 1202 1203 1204 1205 1206 1207 1208 1209 1209 1210 1211 1212 1213 1214 1215 1216 1217 1217 1218 1219 1219 1220 1221 1222 1223 1224 1225 1226 1227 1228 1229 1229 1230 1231 1232 1233 1234 1235 1236 1237 1238 1239 1239 1240 1241 1242 1243 1244 1245 1246 1247 1248 1249 1249 1250 1251 1252 1253 1254 1255 1256 1257 1258 1259 1259 1260 1261 1262 1263 1264 1265 1266 1267 1268 1269 1269 1270 1271 1272 1273 1274 1275 1276 1277 1278 1278 1279 1280 1281 1282 1283 1284 1285 1286 1287 1288 1289 1289 1290 1291 1292 1293 1294 1295 1296 1297 1297 1298 1299 1299 1300 1301 1302 1303 1304 1305 1306 1307 1308 1309 1309 1310 1311 1312 1313 1314 1315 1316 1317 1317 1318 1319 1319 1320 1321 1322 1323 1324 1325 1326 1327 1328 1329 1329 1330 1331 1332 1333 1334 1335 1336 1337 1338 1339 1339 1340 1341 1342 1343 1344 1345 1346 1347 1348 1349 1349 1350 1351 1352 1353 1354 1355 1356 1357 1358 1359 1359 1360 1361 1362 1363 1364 1365 1366 1367 1368 1369 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1378 1379 1380 1381 1382 1383 1384 1385 1386 1387 1388 1389 1389 1390 1391 1392 1393 1394 1395 1396 1397 1397 1398 1399 1399 1400 1401 1402 1403 1404 1405 1406 1407 1408 1409 1409 1410 1411 1412 1413 1414 1415 1416 1417 1417 1418 1419 1419 1420 1421 1422 1423 1424 1425 1426 1427 1428 1428 1429 1430 1431 1432 1433 1434 1435 1436 1437 1438 1439 1439 1440 1441 1442 1443 1444 1445 1446 1447 1448 1449 1449 1450 1451 1452 1453 1454 1455 1456 1457 1458 1459 1459 1460 1461 1462 1463 1464 1465 1466 1467 1468 1469 1469 1470 1471 1472 1473 1474 1475 1476 1477 1478 1478 1479 1480 1481 1482 1483 1484 1485 1486 1487 1488 1489 1489 1490 1491 1492 1493 1494 1495 1496 1497 1497 1498 1499 1499 1500 1501 1502 1503 1504 1505 1506 1507 1508 1509 1509 1510 1511 1512 1513 1514 1515 1516 1517 1517 1518 1519 1519 1520 1521 1522 1523 1524 1525 1526 1527 1528 1529 1529 1530 1531 1532 1533 1534 1535 1536 1537 1538 1539 1539 1540 1541 1542 1543 1544 1545 1546 1547 1548 1549 1549 1550 1551 1552 1553 1554 1555 1556 1557 1558 1559 1559 1560 1561 1562 1563 1564 1565 1566 1567 1568 1569 1569 1570 1571 1572 1573 1574 1575 1576 1577 1578 1578 1579 1580 1581 1582 1583 1584 1585 1586 1587 1588 1589 1589 1590 1591 1592 1593 1594 1595 1596 1597 1597 1598 1599 1599 1600 1601 1602 1603 1604 1605 1606 1607 1608 1609 1609 1610 1611 1612 1613 1614 1615 1616 1617 1617 1618 1619 1619 1620 1621 1622 1623 1624 1625 1626 1627 1628 1629 1629 1630 1631 1632 1633 1634 1635 1636 1637 1638 1639 1639 1640 1641 1642 1643 1644 1645 1646 1647 1648 1649 1649 1650 1651 1652 1653 1654 1655 1656 1657 1658 1659 1659 1660 1661 1662 1663 1664 1665 1666 1667 1668 1669 1669 1670 1671 1672 1673 1674 1675 1676 1677 1678 1678 1679 1680 1681 1682 1683 1684 1685 1686 1687 1688 1689 1689 1690 1691 1692 1693 1694 1695 1696 1697 1697 1698 1699 1699 1700 1701 1702 1703 1704 1705 1706 1707 1708 1709 1709 1710 1711 1712 1713 1714 1715 1716 1717 1717 1718 1719 1719 1720 1721 1722 1723 1724 1725 1726 1727 1728 1729 1729 1730 1731 1732 1733 1734 1735 1736 1737 1738 1739 1739 1740 1741 1742 1743 1744 1745 1746 1747 1748 1749 1749 1750 1751 1752 1753 1754 1755 1756 1757 1758 1759 1759 1760 1761 1762 1763 1764 1765 1766 1767 1768 1769 1769 1770 1771 1772 1773 1774 1775 1776 1777 1778 1778 1779 1780 1781 1782 1783 1784 1785 1786 1787 1788 1789 1789 1790 1791 1792 1793 1794 1795 1796 1797 1797 1798 1799 1799 1800 1801 1802 1803 1804 1805 1806 1807 1808 1809 1809 1810 1811 1812 1813 1814 1815 1816 1817 1817 1818 1819 1819 1820 1821 1822 1823 1824 1825 1826 1827 1828 1829 1829 1830 1831 1832 1833 1834 1835 1836 1837 1838 1839 1839 1840 1841 1842 1843 1844 1845 1846 1847 1848 1849 1849 1850 1851 1852 1853 1854 1855 1856 1857 1858 1859 1859 1860 1861 1862 1863 1864 1865 1866 1867 1868 1869 1869 1870 1871 1872 1873 1874 1875 1876 1877 1878 1878 1879 1880 1881 1882 1883 1884 1885 1886 1887 1888 1889 1889 1890 1891 1892 1893 1894 1895 1896 1897 1897 1898 1899 1899 1900 1901 1902 1903 1904 1905 1906 1907 1908 1909 1909 1910 1911 1912 1913 1914 1915 1916 1917 1917 1918 1919 1919 1920 1921 1922 1923 1924 1925 1926 1927 1928 1929 1929 1930 1931 1932 1933 1934 1935 1936 1937 1938 1939 1939 1940 1941 1942 1943 1944 1945 1946 1947 1948 1949 1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1989 1990 1991 1992 1993 1994 1995 1996 1997 1997 1998 1999 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2049 2050 2051 2052 2053 2054 2055 2056 2057 2058 2059 2059 2060 2061 2062 2063 2064 2065 2066 2067 2068 2069 2069 2070 2071 2072 2073 2074 2075 2076 2077 2078 2079 2079 2080 2081 2082 2083 2084 2085 2086 2087 2088 2089 2089 2090 2091 2092 2093 2094 2095 2096 2097 2097 2098 2099 2099 2100 2101 2102 2103 2104 2105 2106 2107 2108 2109 2109 2110 2111 2112 2113 2114 2115 2116 2117 2117 2118 2119 2119 2120 2121 2122 2123 2124 2125 2126 2127 2128 2129 2129 2130 2131 2132 2133 2134 2135 2136 2137 2138 2139 2139 2140 2141 2142 2143 2144 2145 2146 2147 2148 2149 2149 2150 2151 2152 2153 2154 2155 2156 2157 2158 2159 2159 2160 2161 2162 2163 2164 2165 2166 2167 2168 2169 2169 2170 2171 2172 2173 2174 2175 2176 2177 2178 2178 2179 2180 2181 2182 2183 2184 2185 2186 2187 2188 2189 2189 2190 2191 2192 2193 2194 2195 2196 2197 2197 2198 2199 2199 2200 2201 2202 2203 2204 2205 2206 2207 2208 2209 2209 2210 2211 2212 2213 2214 2215 2216 2217 2217 2218 2219 2219 2220 2221 2222 2223 2224 2225 2226 2227 2228 2229 2229 2230 2231 2232 2233 2234 2235 2236 2237 2238 2239 2239 2240 2241 2242 2243 2244 2245 2246 224

7/7

FIG. 8B



© 2024 D5013



D5013

Please type a plus sign (+) inside this box →

PTO/SB/01 (12-97)

Approved for use through 9/30/00. OMB 0651-0032

Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

**DECLARATION FOR UTILITY OR
DESIGN
PATENT APPLICATION
(37 CFR 1.63)**

Declaration Submitted Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)
OR

Attorney Docket Number	D-5013
First Named Inventor	Larson
COMPLETE IF KNOWN	
Application Number	/
Filing Date	
Group Art Unit	
Examiner Name	

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Wheel Mounted Power Generator and Wheel Condition Sensing Apparatus

the specification of which
 is attached hereto *(Title of the Invention)*
 OR
 was filed on (MM/DD/YYYY) as United States Application Number or PCT International

Application Number and was amended on (MM/DD/YYYY) (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached?
			<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below

Application Number(s)	Filing Date (MM/DD/YYYY)	<input type="checkbox"/> Additional provisional application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

[Page 1 of 2]

Burden Hour Statement This form is estimated to take 0.4 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO Assistant Commissioner for Patents, Washington, DC 20231.

Please type a plus sign (+) inside this box → +

Approved for use through 9/30/00 OMB 0651-0032

Patent and Trademark Office: U S DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number**DECLARATION — Utility or Design Patent Application**

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)					
<input type="checkbox"/> Additional U.S. or PCT international application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.							
As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith <input type="checkbox"/> Customer Number _____ → <input type="checkbox"/> Place Customer Number Bar Code Label here <input checked="" type="checkbox"/> Registered practitioner(s) name/registration number listed below							
Name	Registration Number	Name	Registration Number				
SULLIVAN, DENNIS KELLY	26,510	GILBERTO HERNANDEZ	46,483				
CALFA, JEFFREY P.	37,105						
POWELL, NEIL T.	45,020						
<input type="checkbox"/> Additional registered practitioner(s) named on supplemental Registered Practitioner Information sheet PTO/SB/02C attached hereto							
Direct all correspondence to: <input type="checkbox"/> Customer Number _____ OR <input checked="" type="checkbox"/> Correspondence address below							
Name	INTERNATIONAL TRUCK AND ENGINE CORPORATION						
Address	455 North Cityfront Plaza Drive						
Address	Suite 1300						
City	Chicago	State	IL				
Country	USA	Telephone	312-836-2311				
		Fax	312-836-3982				
I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.							
Name of Sole or First Inventor:		<input type="checkbox"/> A petition has been filed for this unsigned inventor					
Given Name (first and middle if any)		Family Name or Surname					
Gerald L.		Larson					
Inventor's Signature				Date			
Residence: City	Fort Wayne	State	IN	Country	USA	Citizenship	USA
Post Office Address	9603 W. Cove Court						
Post Office Address							
City	Fort Wayne	State	IN	ZIP	46804	Country	USA
<input type="checkbox"/> Additional inventors are being named on the _____ supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto							